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**Advances in sorption systems for energy efficient heating and cooling**

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At present there is important R&D in the field of sorption heating, cooling and thermal energy storage systems going on worldwide. Sorption systems can enable a more efficient use of renewable energies (solar, geothermal, etc.) both for domestic and industrial applications. This special issue presents the recent advances in the following key-sorption technologies:

- Ad-sorption and ab-sorption closed- cycle heat pumps and chillers.
- Ad-sorption and ab-sorption open-cycle systems for air conditioning, dehumidification, solar cooling, etc.
- Sorption and thermochemical systems for thermal energy storage.

The following major trends of R&D in the field are addressed in this special issue, after a comprehensive review on materials and technologies [1]: new working pairs and novel sorption materials, advanced heat and mass transfer, new component design, applications and examples, and system optimization.

Absorption heat pumps commercial working pairs are ammonia/water and water/lithium bromide. These working pairs are still being optimized [2], but today alternative working pairs are being developed. To compare those new working pairs thermodynamically, dimensionless parameters and key thermophysical properties are identified and compared, showing that low molecular weight rations between absorbent and refrigerant is beneficial to the coefficient of performance (COP) and the circulation ratio [3].

Advances in materials are going on. Novel adsorbents to be used for transformation and storage of low temperature heat presented are zeolites, aluminophosphates composites, and metal-organic frameworks [4]. An example of such developments is the development of composite materials, such as a polymer composite used as fixed bed containing high metal fraction [5], and the development of alumina-silica zeolites with popyltrimethoxy silane as binder [6]. Classical working pairs in adsorption are not suitable for new applications, therefore, new working pairs are studied today [7].

Sorption systems can be closed systems (in chillers and heat pumps) and open systems (for dehumidification). Recent work presents, for example, semi-open systems, driven by solar, waste, or combustion heat, and able to be used in heat pumping or chilling using ambient humidity as working fluid [8].

Adsorption heat pumps are used as an efficient solution for space heating and domestic hot water production in buildings. The use of adsorption heat pumps with renewable heat sources means having low temperature input, which leads to low specific power and to large-size units. Current research shows that two ways to start the vapour adsorption process, jumping vapour pressure over an adsorbent or dropping the temperature of a metal plate where the adsorbent is situated [9]. Performance of adsorption heat pumps in real buildings needs long term monitoring campaigns and the definition of key performance indicators (KPIs) such as the primary energy ratio (PER), defined as the ratio of the total useful energy to the total primary energy inputs [10]. Moreover, modelling tools for the design and evaluation of such systems are developed and tested in real case studies [11].

Development in sorption components, mainly heat exchangers, is another key research aspect. Selection and design of evaporators for adsorption heat pumps, chillers, and storage devices needs of performance correlations and sizing guidelines. Research shows that the evaporation performance in thin film operation is governed by the fluid size heat transfer and the wetting conditions; moreover, in partially flooded operation, the performance depends on the filling level [12]. New heat exchangers have been developed, such as a new type of heat exchanger based on aluminium sintered metal fibre structures brazed on flat fluid channels [13] or a falling film tube bundle heat and mass exchanger unit [14]. Component development and new working pairs has shown the need to ensure long term stability, for example, reducing corrosiveness within the systems [15].

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